MCR-73-286
Contract NAS8-29777

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Interim
Report

October 1973

Universal Stowage Module for Future Space Exploration

(NASA-CR-124465) UNIVERSAL STOWAGE MODULE FOR FUTURE SPACE EXPLORATION Interim Report (Martin Marietta Corp.) ~~38~~ 35 p HC $4.00 CSCL 22B

N73-33832

Unclas
G3/31 15798

Prepared for:

National Aeronautics and Space Administration

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MARTIN MARIETTA

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INTERIM REPORT

UNIVERSAL STOWAGE MODULE FOR FUTURE SPACE EXPLORATION

OCTOBER 1973

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FOREWORD

This interim report describes the design of the Universal Stowage Module that is intended for use on Shuttle payloads. This document presents the results of work performed by the Martin Marietta Corporation's Denver Division for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center. This interim report was prepared as partial fulfillment of Contract NAS8-12777, Universal Stowage Module for Future Space Exploration. The NASA Technical Monitor was Mr. Paul Artis, of the Astronautics Laboratory, Mechanical and Crew Systems Integration Division.

ABSTRACT

This interim report describes the design effort accomplished under contract NAS8-29777 to develop, design, and fabricate a prototype Universal Stowage Module with universal restraints that are readily adaptable for most sizes and shapes of items that would be launched into space and returned aboard shuttle payloads.

CONTENTS

I. INTRODUCTION

The objective of this contract is to develop, design, and fabricate a prototype stowage module, with internal restraints, that can be used for stowage of any of the items that are normally launched to support a space mission. These items could be of any size or shape and would typically include food experiment hardware, consumables, food, clothing, tools, etc. The universal stowage module is intended for use on shuttle payloads and future space missions.

The current designs for stowage lockers are not suitable for universal stowage. Several different locker configurations were supplied for the Skylab program, and many of them were one-of-a-kind designs specifically designed to stow experiment hardware. The other lockers required special mounting provisions, filler materials, and peculiar vibration isolation configurations. The majority of the lockers were not removable from the vehicle and thus the equipment had to be loaded on the vehicle, rather than in the locker, prior to launch. It was also difficult to change the contents, and the locker nomenclature, just prior to launch.

The lockers were not symmetrical in their dimensions, were of different sizes and shapes, had different load capacities, exhibited various external mounting provisions, and did not lend themselves to a consistent simple method of defining interface criteria. In addition, the mounting hardware and fasteners were not designed for commonality.

The universal stowage module described in this report corrects the problems experienced on past missions. The primary design criteria was that the stowage module be universal in accommodating most sizes and shapes of items that would be launched and returned in a shuttle payload, and that it withstand the vibration criteria and loads imposed during launch, and upon return to earth.

This report describes the design criteria, design analysis, the rational used in the design of the Universal Stowage Module.

II. DESIGN CRITERIA

The design, environmental, and material criteria listed in the contract are shown in sections A, C, and D. Design guidelines that are desirable to satisfy the design intent of the stowage modules are listed in section B.

The basic intent of the design is to provide a stowage locker that can be loaded by an experiment investigator or contract supplier at some remote location. The locker could then be shipped to the launch site, and installed into the shuttle in either a horizontal or vertical configuration. It is desirable that the design accommodate last minute changes prior to launch in either the contents, module nomenclature, or module location. When on-orbit--the module, module drawers, or contents can be removed and transported to another location within the shuttle payload. Drawers, dividers, and nomenclature are interchangable between modules.

The module is designed so that human factors design is maximized whenever possible with attention to rounded edges, captive fasteners, commonality, minimum motion and crew effort, tool requirements, etc. The interior dimensions can be revised to the optimum dimensions when the shuttle crew compartment and the shuttle payload interior are better defined.

A. DESIGN CRITERIA

1. Provide a Universal Module that will accommodate most sizes and shapes of items that possibly would be launched into space and returned (within the limits of the interior volume and shape of the stowage compartment).

2. Reduce interface control documentation.

3. Must withstand the launch and operating environment described in the statement of work.

4. The interior dimensions of the stowage module shall be .607 meter x .607 meter x .607 meter (2 feet x 2 feet x 2 feet).

5. The maximum weight of the contents stored in the module will not exceed 36.3 kilograms (80 pounds).

6. The maximum density of the module contents shall be 416 kilograms per cubic meter (26 pounds per cubic feet).

7. The maximum allowable empty weight of the module shall be 31.7 kilograms (70 pounds).

8. Provide adequate restraints within the locker so that a wide variety of items may be secured.

9. Design for ease of operation for loading and unloading in 1-G and zero-g environment.

B. DESIGN GUIDELINES

1. The module design should facilitate loading at a remote location with later installation in the spacecraft in a horizontal or vertical position.

2. The Skylab stowage list shall be considered as being representative of the type hardware that will be stowed in the universal stowage module.

3. The restraint system and module design should accommodate last minute changes prior to launch.

4. The module size should be such that it can be transported thru a one meter diameter hatch by one crew member in a zero-g environment.

5. Design so that the locker (or portion of the locker) can be removed from its mount and transported to other areas of the spacecraft in zero-g.

6. The basic spacecraft may be defined as a shuttle payload that is cylindrical in shape with docking port(s) on the end(s). The maximum diameter shall be 15 feet.

C. ENVIRONMENTAL CRITERIA

1.0 Launch and Reentry Loads

1.1 Vibration

1.1.1 Sinsusoidal Vehicle Dynamics Environment - The component shall withstand the following environment. Logarithmic sweep at the rate of 3.0 octaves/minute from the low frequency to the high frequency in the thrust direction, 3 Hz to 60 Hz (4.3 octaves).

3 - 7 Hz at 0.43 inch D. A. Disp.
7 - 14 Hz at 1.1 g peak
14 - 25 Hz at 0.11 inch D. A. Disp.
25 - 60 Hz at 3.6 g peak

The component shall withstand the following environment. Logarithmic sweep at the rate of 3.0 octaves/minute from the low frequency to the high frequency in the radial and tangential directions, 2 Hz to 20 Hz (3.3 octaves).

2 - 4 Hz at 0.34 inch D. A. Disp.
4 - 7 Hz 0.28 g peak
7 - 20 Hz 0.08 g peak

1.1.2 Sinusoidal Vibration Evaluation - The component will be subjected to the following excitation. Logarithmic sweep at the rate of 1.0 octave/minute from the low frequency to the high frequency in three mutually perpendicular directions. 20 Hz to 2,000 Hz (6-2/3 octaves).

20 - 100 Hz at 0.002 inches D. A. Disp.
100 - 2000 Hz at 1 g peak

1.1.3 Random Vibration Environment - The component will withstand the specified random vibration for 1.0 minute in each of the three mutually perpendicular directions. The excitation will be applied as one input over the frequency interval from 20 to 2,000 Hz.

20 - 100 Hz at +9 dB/octave
100 - 250 Hz at $1g^2/Hz$
250 - 2000 Hz at -6 dB/octave

2.0 Steady State Load Factors

2.1 Orbiter Payload Load Factors

Structure Load Factors (Max G)

Direction	Steady State	Design Limit	Crash
X-Axis	+3.0, -1.0	$\pm$ 4.5	-8.0, +1.5
Y-Axis	+1.0	$\pm$ 2.0	+1.5
Z-Axis	+1.0	$\pm$ 3.0	+4.5, -2.0

2.2 Operating Temperature

The minimum operating temperature will be 50°F. The maximum operating temperature will be 90°F.

2.3 Operating Atmosphere

The atmosphere during operation will be approximately eighty (80) per cent nitrogen and approximately twenty (20) per cent oxygen. The pressure will be 14.7 psia.

2.4 Humidity

The operating range of the relative humidity will be thirty (30) per cent minimum and ninety-five (95) per cent maximum.

D. MATERIAL SELECTION CRITERIA

1.0 Control of material for flammability can be achieved through the use of an existing standard developed for this purpose by the Federal Aviation Administration, Publication FAR 25, Airworthiness Standard, and actively maintained to the state-of-the-art. This specification provides the requirements of fire safe aircraft for all commercial passenger travel by U. S. carriers. As such, it provides for the use and control of materials in a vehicle/craft operating in a nominal earth atmosphere.

2.0 Odor and outgassing are still part of the hazards of a closed system, unlike earthbound aircraft, and require the same rigid control now exercised for current spacecraft. Some relief is realized in the increase in atmospheric pressure

as the outgassing and attendant odors will generally be less severe. While this would make more materials available, it does not modify the levels of contaminants that are acceptable and the need for matching vehicle system scrubbing capabilities to contaminant contributions. For control of odor and outgassing, MSFC-SPEC-101B modified, would be applicable.

3.0 Requirements for control of nometallic materials for odor and offgassing will be in accordance with applicable portions of MSFC-SPEC-101B, inhabited area, with the following modifications:

3.1 The classification of materials by type for usage locations and applications (paragraphs 1.2.2, 3.2.2.1 and subs, and Table 1) is not required.

3.2 The material control plan submitted is waived.

3.3 Batch lot testing (paragraph 3.2.1) is not required.

3.4 Test No. 9 is applicable but will be conducted by the Government as required.

4.0 Requirements for nonmetallic material flammability control will be in accordance with applicable portions of Federal Aviation Regulation Volume III transmittal Part 25 with the following modifications:

Applicable Section:

Fire Protection

Modifications:

Burning drippings or spatter (paragraph 25.853 (a, b)) from the test specimen during or after removal of the flame is not permitted.

III. DESIGN DESCRIPTION

A. UNIVERSAL STOWAGE MODULE

The basic module, Figure III-1, has interior dimensions of .607 meter x .607 meter x .607 meter (24 x 24 x 24 inches) with smooth flat surfaces on all of the interior surfaces. The primary restraining concept of the module is a grid of calfax fastener receptacles on each wall of the module whereby equipment, dividers, tie-down devices, and drawer systems can be mounted.

Each wall panel has a grid of 65 calfax fastener receptacles spaced on 5 centimeter (2 inch) centers around the edge of each panel, and at 10.16 centimeter (4 inch) centerlines in the center portion of the panel. The design is such that the calfax fastener grid can be expanded to a 5 centimeter (2 inch) grid to achieve maximum utilization. The calfax fastener used here is the same as that used on the Skylab missions, which proved to be highly successful in actual mission use. The calfax fastener requires 1-1/2 turns for total engagement.

The module panels are constructed from 2024-T3 aluminum that has been anodized for protection against corrosion. The panel construction consists of two panels; the outer panel is a beaded panel with ten beads on 5 centimeter (2 inch) centers, and it is spot welded to an inner panel that provides added strength and a smooth inside surface on the module walls and back panel. The smooth inside walls provide a flat surface for maximum load carrying capability, and also simplifies the interface documentation. The smooth surfaces and flush corners lend themselves to better cleaning and contamination control.

The two module doors swing out from the center of the module to allow full and clear access to the module contents. Either door can be opened as desired, and do not require one door to be opened before the other. The same proven door latches as was used on the Skylab lockers are being used here. With this type latch, the doors can be opened or closed (slammed) with a one-handed operation. Each door has its individual lock. The door hinges are spring loaded so that they will stay positioned in zero-g.

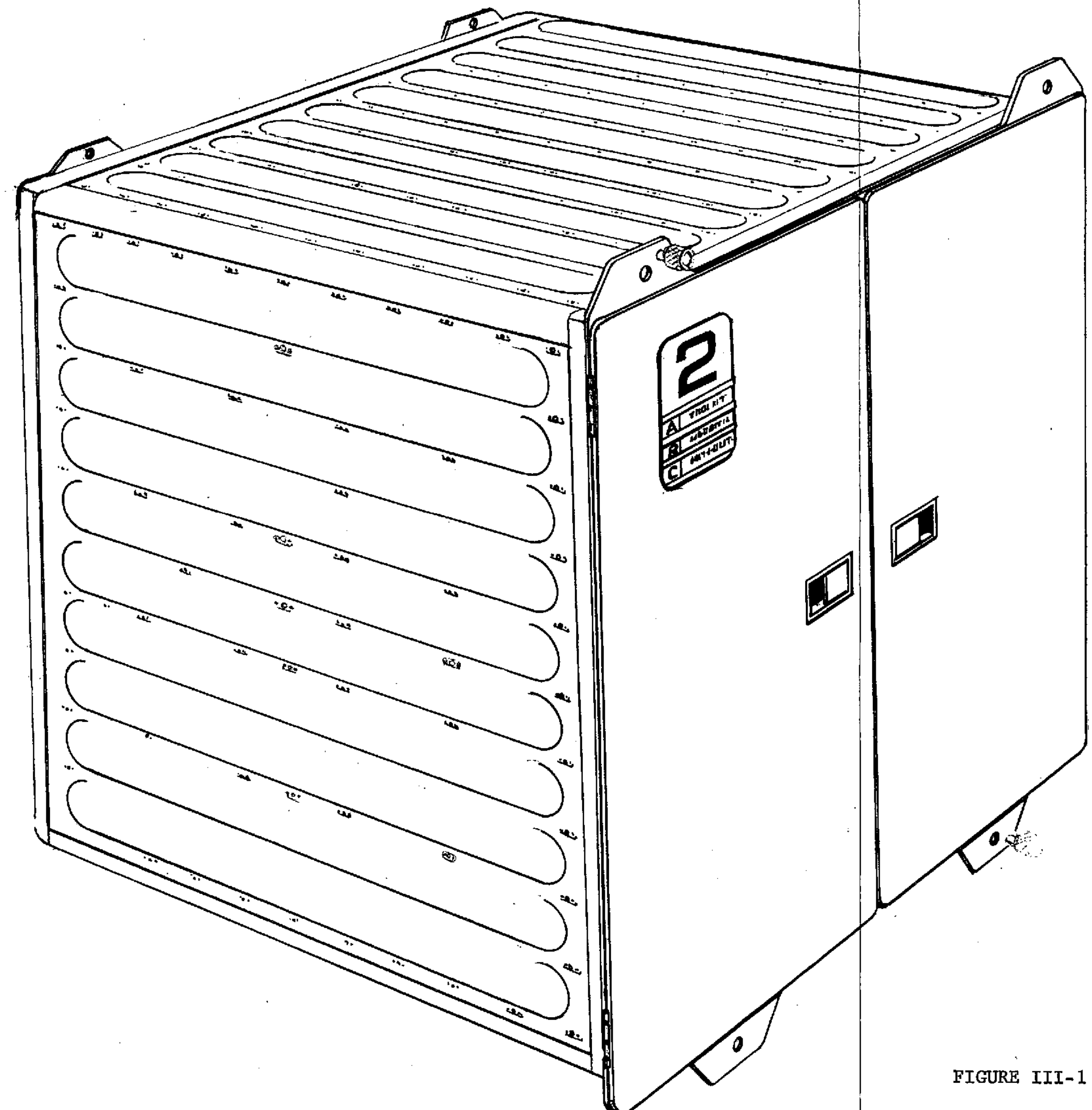


FIGURE III-1 UNIVERSAL STOWAGE MODULE

FOLDOUT FRAME 1

FOLDOUT FRAME 2

A nomenclature card, Figure III-2, is positioned on the left hand door, in the upper left hand corner. Each module will have its individual module number, and the nomenclature card will be color coded as to the general category of equipment being stowed in the module. The nomenclature card is designed so that the information can be easily typed on the card, and revised just prior to launch. In flight, the card could be reversed in its holder and the revised information written in with a felt tip pen. The nomenclature card is recessed flush with the door to prevent damage to the card or card holder.

B. SPACECRAFT INSTALLATION

One method of installing the universal module in the shuttle payload is shown in Figure III-3. Although it is not a requirement of this contract to design or supply the spacecraft installation system, the method of installation does affect and is an integral part of the stowage module design.

Figure III-3 shows a "jungle-gym" approach to mounting the stowage modules. The module is guided in on teflon guide rails so that the guide pins (.65 centimeters, 1/4 inch) engage the rear flange of the stowage module, which in turn, take out launch loads. The take-up wedge at the front of the module aligns the front flange, and four .96 centimeters (3/8 inch) bolts are used to take out the loads at the front flange. The four mounting tabs on the front flange serve to orientate the module so that it can only be installed in one orientation for launch. The two calfax fasteners are used to temporarily hold in the module during zero-g operations when the module is being moved from the launch position to other use locations within the spacecraft.

The guide rails, Figure III-4, are tapered from front to back so that the module can be easily positioned in the "jungle-gym" system. Approximately 1.27 centimeters (1/2 inch) of take-up is provided from front to back.

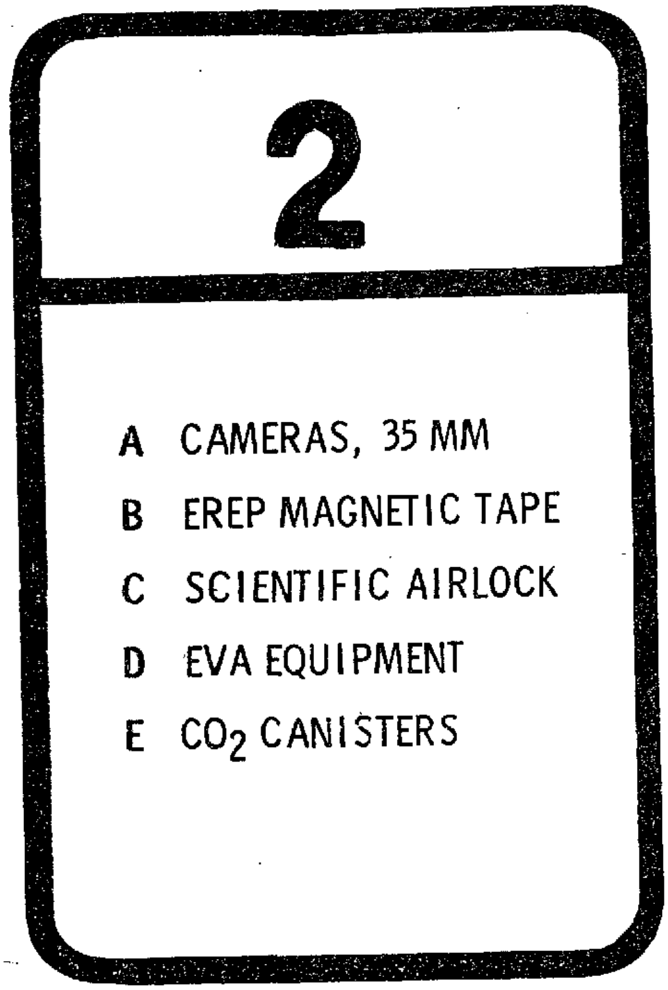
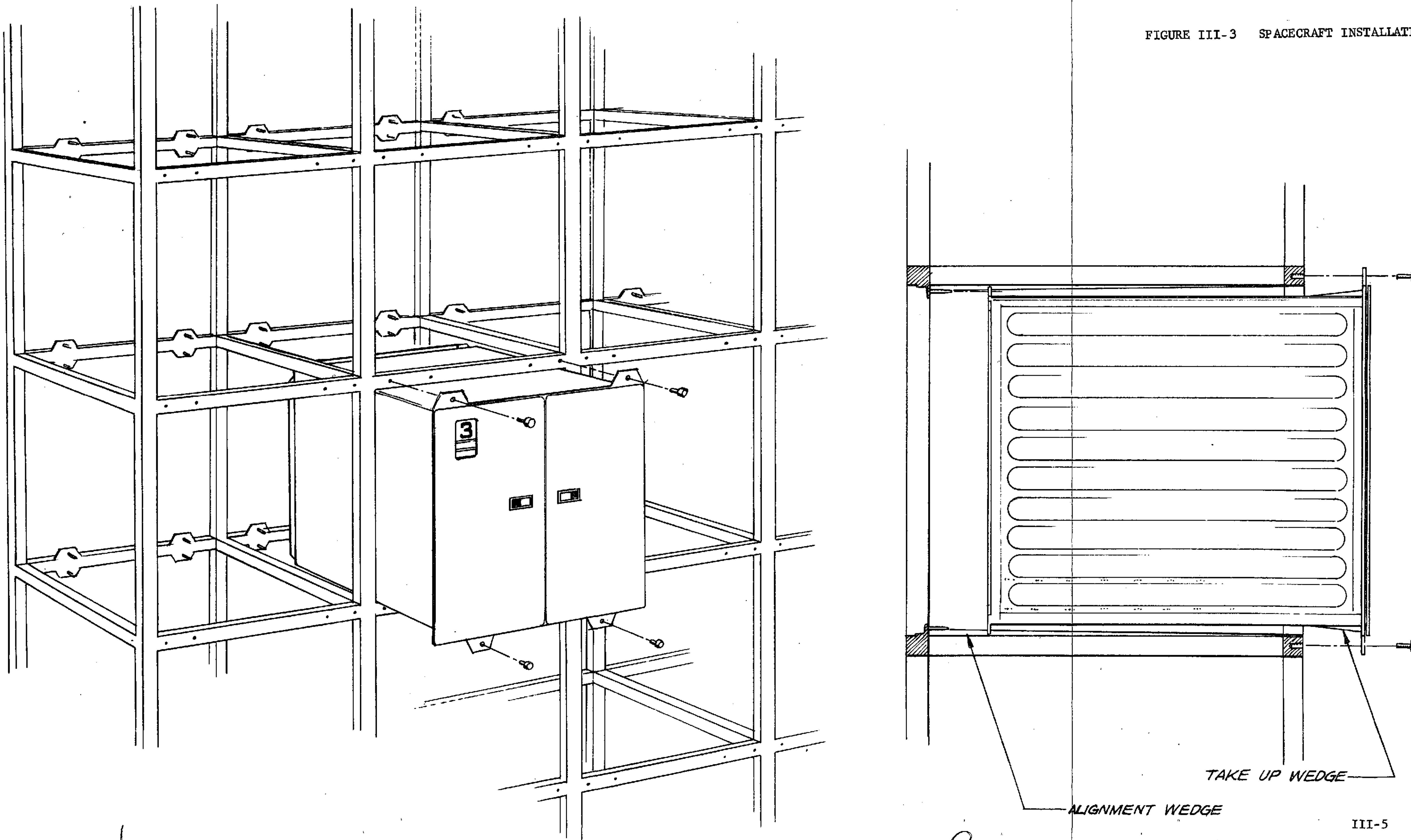
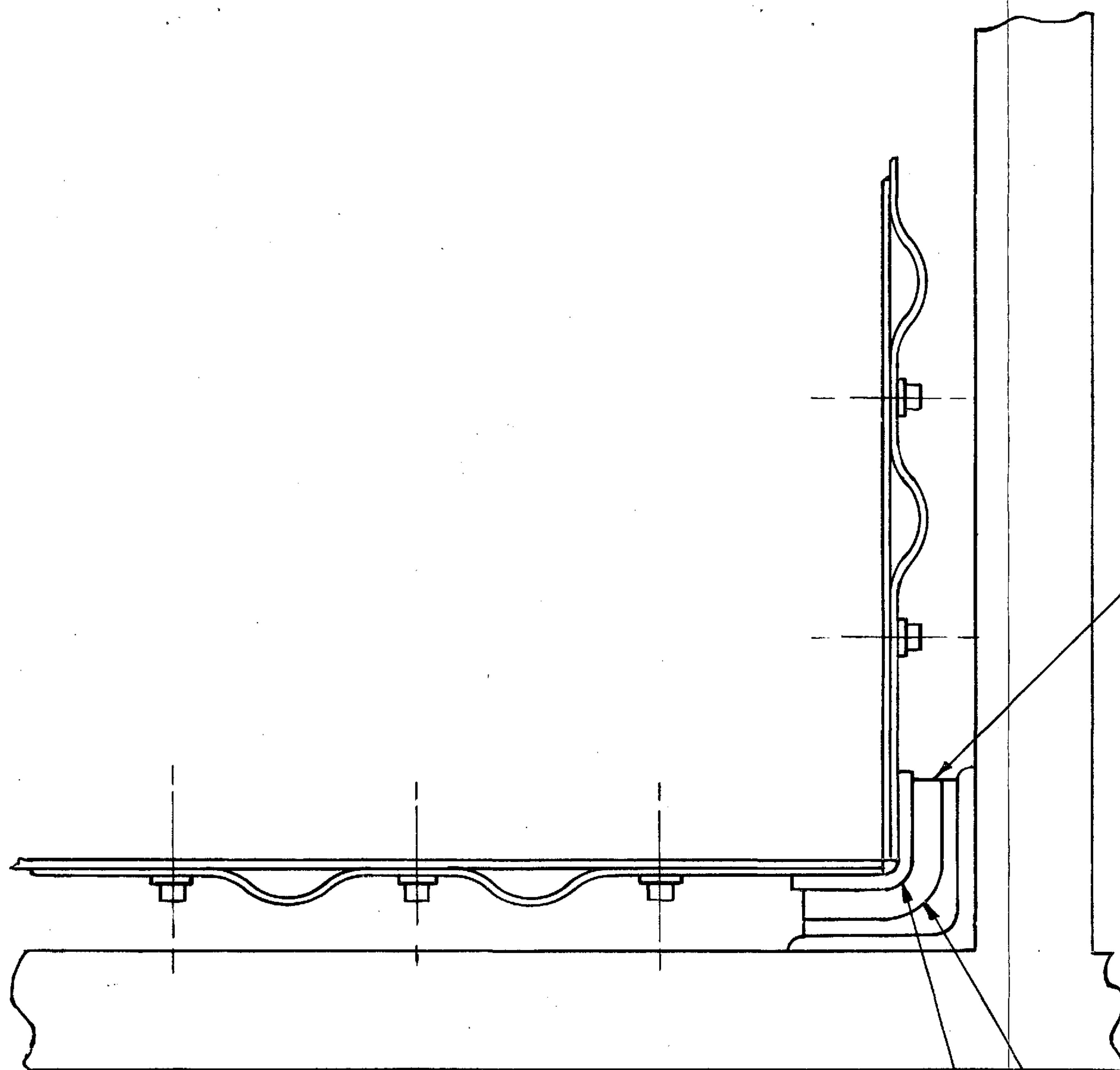


FIGURE III-2 NOMENCLATURE CARD

FIGURE III-3 SPACECRAFT INSTALLATION




WEDGE
RADIUS AT REAR
RADIUS AT FRONT END

C. CENTRAL DIVIDER

The central divider, Figure III-5, is used to divide the total module into subsections, to provide two more surfaces for mounting equipment, and as a structural member to fasten the drawer divider to.

The central divider has a grid of calfax fastener receptacles on each surface spaced on 10.16 centimeter (4 inch) centers. This grid can be used for mounting equipment or subsection dividers such as the drawer divider system.

Two tee-section guide rails are mounted to the module walls with countersunk calfax studs, and the divider is guided into position by these rails. The divider can be mounted in either the horizontal or vertical position. A total of fourteen positions are available for mounting the divider. The divider has six tapered pins that fix the divider to the guide rails and prevent failure during vibration.

D. DRAWER SYSTEM

A drawer system, Figure III-6, is part of the basic concept in univeral stowage. The drawers are mounted on KEL-F guide rails for smooth operation and are designed to restrain the drawers during vibration. The male portion of the guide rail on the drawer is of the same cross section as the "universal mount" and thus the drawer can be removed from the module, as in the case of a tool drawer, and used at the work station. The drawer design is similar to a safety deposit box such that the lid can be opened without having to remove the drawer. Each drawer handle is detented so that it will stay in the desired position. The drawer lid is also detented so that it will stay closed during transportation. The front edge of the lid protrudes out as a lip for opening the lid.

Four of the drawers exhibit interior packaging concepts. One drawer has a divider system so that the interior volume of the drawer can be divided into 2.54 centimeter (1.0 inch) increments. One drawer is fully lined with mosite foam rubber to show vibration protection. Bubblepack protection and soft cloth wrapping are exhibited in the other two drawers.

The drawer suspension system is modularized into 1/4 sections

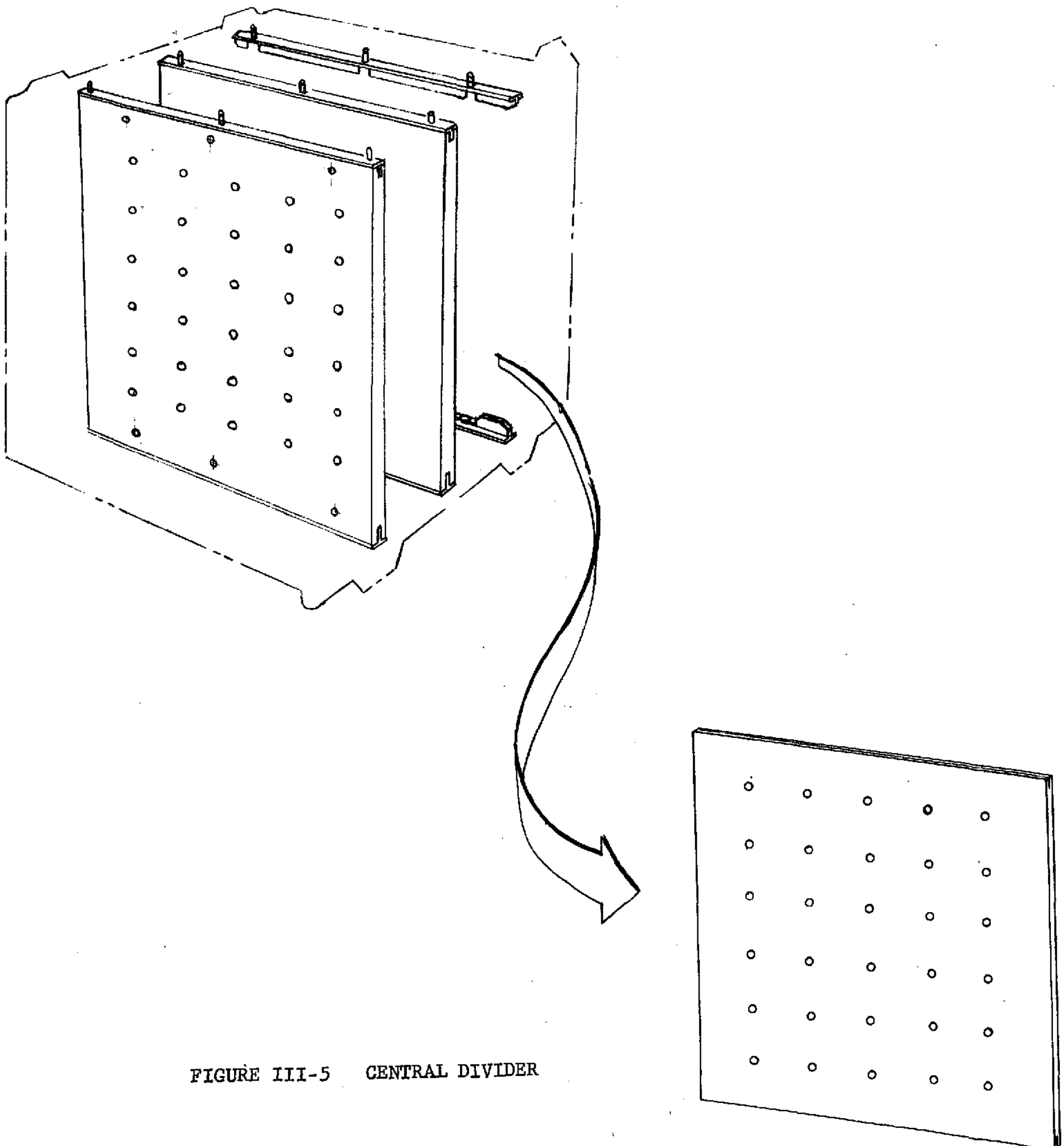


FIGURE III-5 CENTRAL DIVIDER

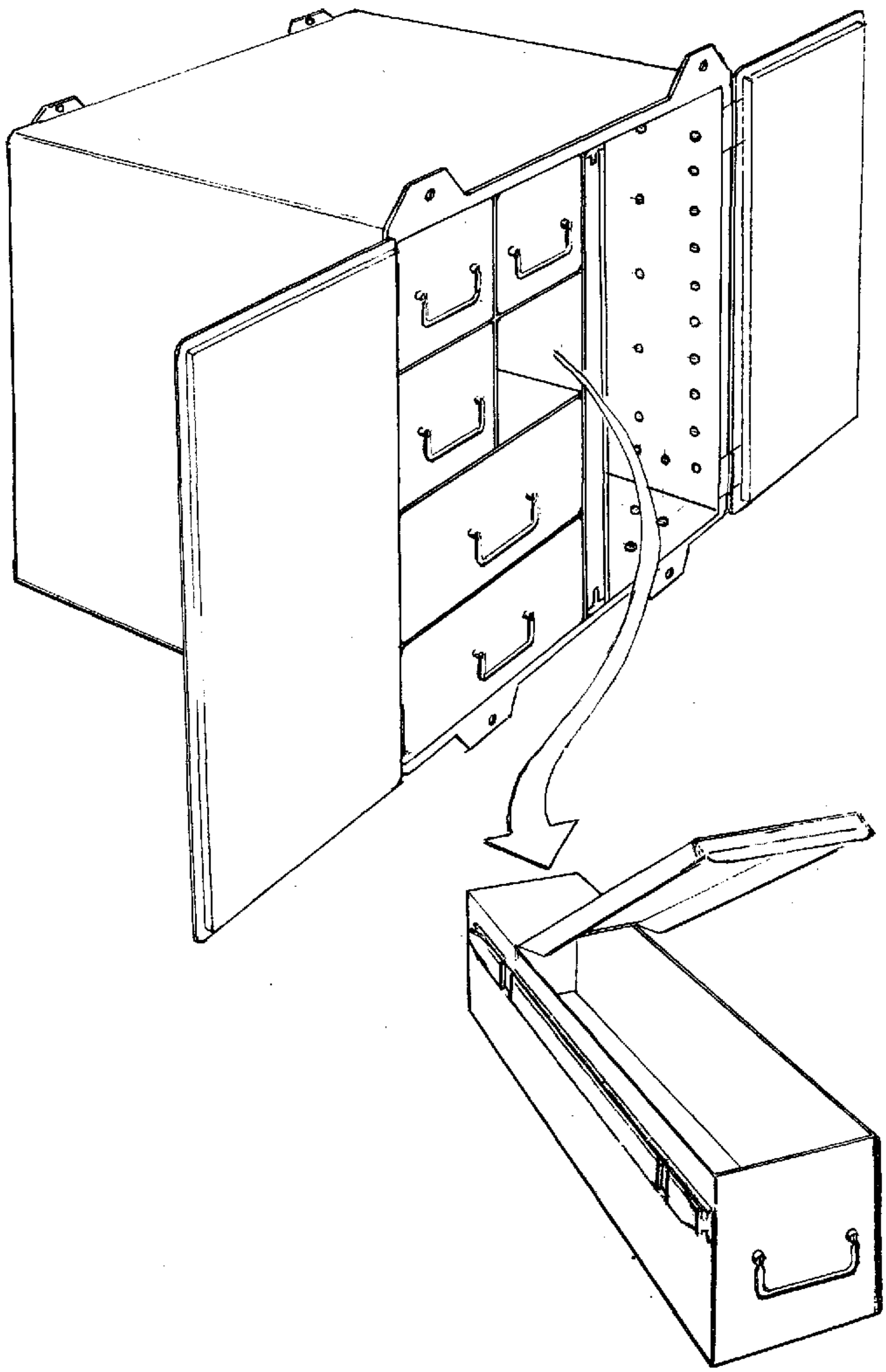


FIGURE III-6 DRAWER SYSTEM

so that any combination of 1/4 section drawers down to 1/16 section drawers (both horizontal and vertical) can be used in the universal stowage module. In addition, the drawer guides are designed such that in zero-g the drawers can be reorganized into another stowage module. The drawers are held in place during launch (front to back movement) by foam rubber pads which bear against the door.

E. UNIVERSAL TIE-DOWN DEVICE

The universal tie-down, Figure III-7, is a ratchet type device with a flexible cloth band that can be used to hold down large objects such as a CO_2 canister. The system consists of a ratchet take-up, the flexible cloth band, and an anchor. The cloth band is simply looped over the equipment to be restrained and hooked into the anchor, then the ratchet device takes up the tension in the band. Both the ratchet and the anchor is fixed to either the module walls or to the divider by means of calfax fasteners.

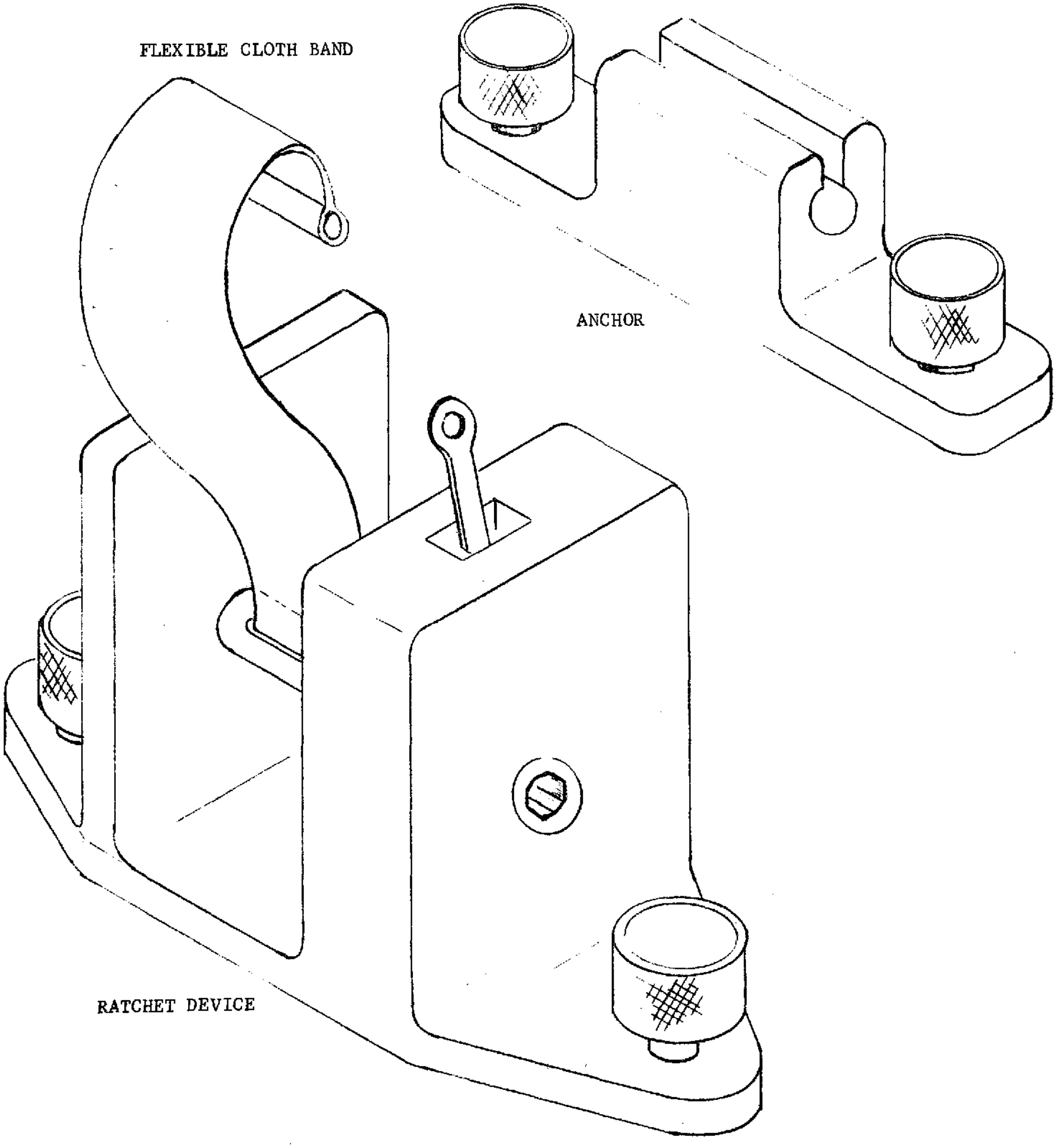


FIGURE III-7 UNIVERSAL TIE-DOWN DEVICE

IV. STRESS AND DYNAMICS ANALYSIS

A. DYNAMICS AND LOADS

A study has been conducted to determine preliminary design load factors for the "Universal Stowage Module". Random vibration and vehicle dynamics are the only environmental conditions considered to date for loads calculations. Because there are an infinite number of stowage configurations possible, and because methods of stowing items in the modules are in the conceptual stage, the approach summarized here was followed to develop a set of general design curves.

1. Assumptions

Vibration and response analyses conducted were limited to the following conditions and assumptions.

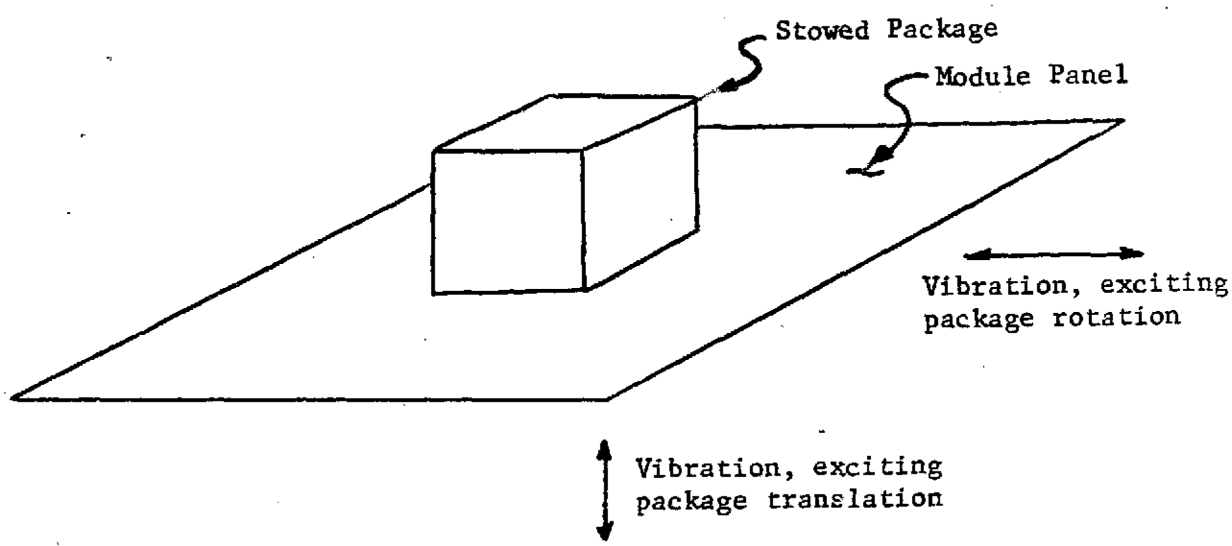
a. Each stowed item was assumed to be mounted to a single wall panel, with only one item to a panel. No internal partitioning or support structure was considered.

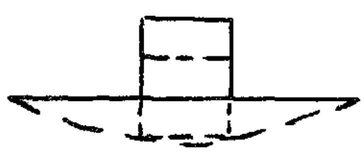
b. The mass of an item stowed in the module was assumed to be either concentrated at a point or in a package of cubic shape of uniform density. Assuming that the mass was concentrated at a point resulted in maximum loading. Though this condition is unrealistic, it represents a limiting case for a very dense item of small volume. The cubic package was assumed to have a density of 416 kilograms per cubic meter (26.0 lbs/cubic foot) which represents the maximum package density expected.

c. Each package was assumed to be centered on a module panel. The load from a point mass acts at the center of the panel and the load from a finite mass acts at the four corners of the package. As a result of this, no unsymmetric panel loading conditions have been evaluated.

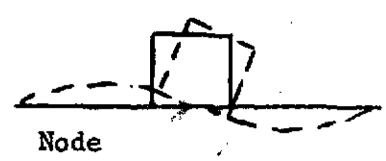
d. For vibration analyses, coupling between translation and rotation of a package has been neglected. The frequency equation used was derived by the Rayleigh method assuming the panel edges to be simply supported. The

following diagrams illustrate the vibration mode shapes assumed for calculating preliminary design load factors.





Translation



Rotation

Actual panel boundary conditions are somewhere between simply supported and fixed but the Rayleigh method usually results in frequencies higher than actual; therefore, the assumption of simply supported edges should result in more realistic frequency calculations. It should also be noted that response in higher vibration modes has been neglected for this study.

2. Results

The results of the study are summarized in Tables IV-1 through IV-3 and Figures IV-1 through IV-3. Tables IV-1 through IV-3 show fundamental frequencies calculated for some specific panel loadings with the corresponding response to random vibration and vehicle dynamics. Maximum acceleration of the package center of gravity is shown along with deflection at the panel center. Panel center deflections were used to calculate "equivalent static load factors" which are plotted versus the panel loading in Figures IV-1 through IV-3. These curves were used by Stress group personnel to check the module basic structure and support bracketry for various stowage configurations.

For a particular stowage configuration being evaluated, an equivalent static load can be obtained for each package from the appropriate curve-translation when the package is being excited perpendicular to the panel and rotation when the package is being excited parallel to the panel. See the following illustration.

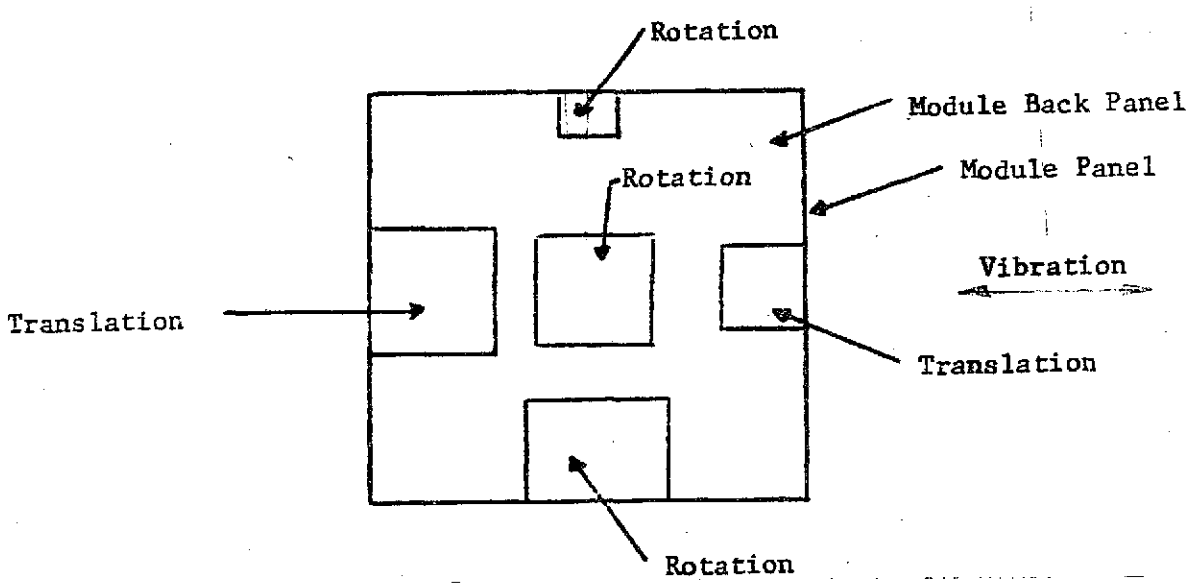


Table IV-1 Cubic Mass at Center of Panel
Translation Perpendicular to Panel

Q = 25.

				Vehicle Dynamics		Random Vibration	
Load Size, Cube (inches per side)	W (lbs)	$I_{c.g.}$ ($lb\text{-}in^2$)	f (Hz)	Accel. at Package c.g. (g)	Deflection at Panel Center (inch)	2.24σ Accel. of Package (g)	2.24σ Defl. at Panel Center (inch)
8.	7.70	82.1	68.0	25.2	0.1103	65.5	0.1755
10.	15.05	251.	56.3	90.0	0.396	45.8	0.207
12.	26.0	623.	52.1	90.0	0.566	39.3	0.252
14.	41.3	1350.	56.3	90.0	0.654	45.8	0.342
16.	61.6	2630.	61.7	90.0	0.775	54.1	0.448
18.	87.7	4740.	81.9	7.56	0.0934	94.1	0.706
20.	120.3	8030.	145.7	5.04	0.1399	169.4	0.836

Table IV-2 Cubic Mass at Center of Panel
Rotation on Panel

Q = 25.

Load Size, Cube (inches per side)	W (lbs)	$I_{c.g.}$ ($lb\text{-}in^2$)	f (Hz)	Vehicle Dynamics: Accel. at Package c.g. (g)	Vehicle Dynamics: Defl. at Center of Half-Panel (inch)	Random Vibration: 2.24σ Accel. of Package (g)	Random Vibration: 2.24σ Defl. at Center, Half-Panel (inch)
8.	7.70	82.1	134.	5.04	0.00544	162.2	0.1128
10.	15.05	251.	94.0	6.30	0.00907	121.8	0.1688
12.	26.0	623.	76.8	9.0	0.01908	83.4	0.1844
14.	41.3	1350.	71.3	16.2	0.0551	72.0	0.218
16.	61.6	2630.	75.8	10.8	0.0400	81.0	0.281
18.	87.7	4740.	95.5	6.48	0.0253	128.0	0.420
20.	120.3	8030.	157.1	4.68	0.01943	171.7	0.434

Table IV-3 Concentrated (Point) Mass at Center of Panel
Translation Perpendicular to Panel

Q = 25.

W (lbs)	$I_{c.g.}$ ($lb\text{-}in^2$)	f (Hz)	Vehicle Dynamics: Accel. of Point Mass & Panel Center (g)	Vehicle Dynamics: Deflection at Panel Center (inch)	Random Vibration: 2.24σ Accel. of Point Mass & Panel Center (g)	Random Vibration: 2.24σ Defl. at Panel Center (inch)
0.	-	152.1	3.96	0.0008	173.	0.0725
2.	-	129.1	4.68	0.0033	159.2	0.0937
5.	-	87.6	6.84	0.0083	107.4	0.1377
10.	-	63.8	32.4	0.0773	57.0	0.1378
20.	-	46.0	90.	0.383	30.1	0.1398
40.	-	32.4	90.	0.766	14.9	0.1398
60.	-	26.6	90.	1.15	10.0	0.1386
80.	-	23.1	75.	1.345	7.68	0.1408

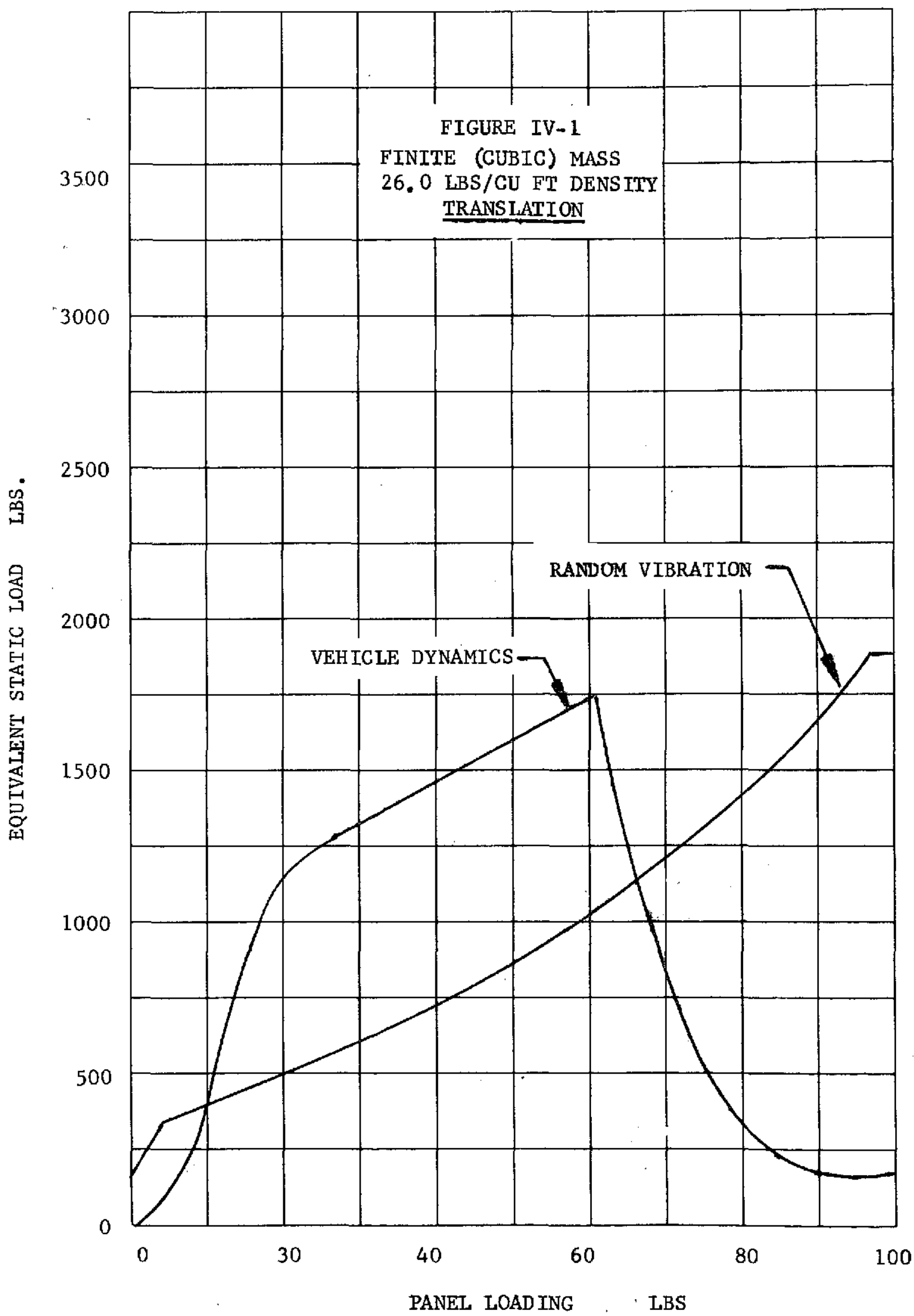


FIGURE IV-1
FINITE (CUBIC) MASS
26.0 LBS/CU FT DENSITY
TRANSLATION
RANDOM VIBRATION
VEHICLE DYNAMICS
3500
3000
2500
2000
1500
1000
500
0
0
30
40
60
80
100
EQUIVALENT STATIC LOAD LBS.
PANEL LOADING LBS

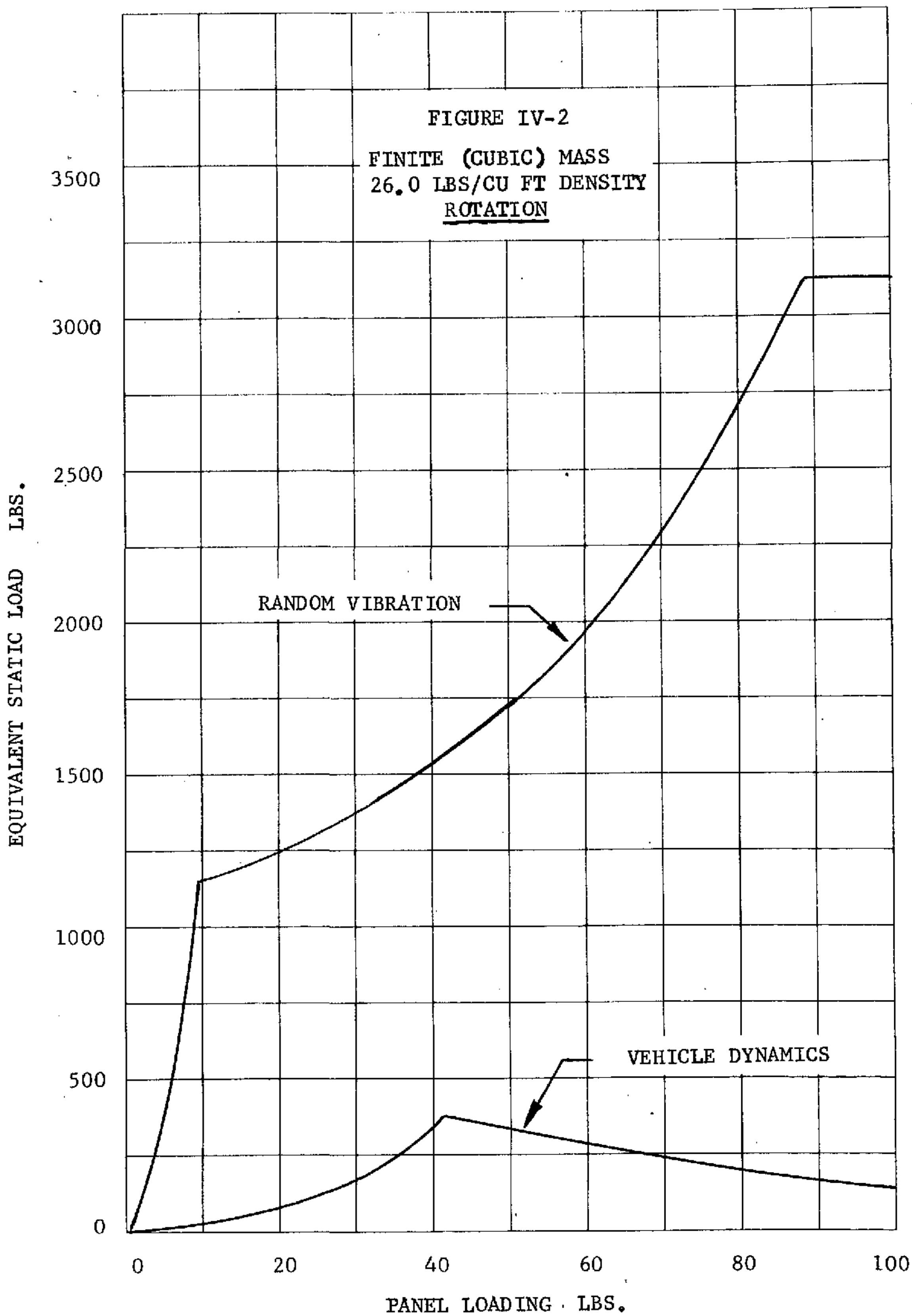


FIGURE IV-2
FINITE (CUBIC) MASS
26.0 LBS/CU FT DENSITY
ROTATION
RANDOM VIBRATION
VEHICLE DYNAMICS
EQUIVALENT STATIC LOAD LBS.
PANEL LOADING LBS.
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100

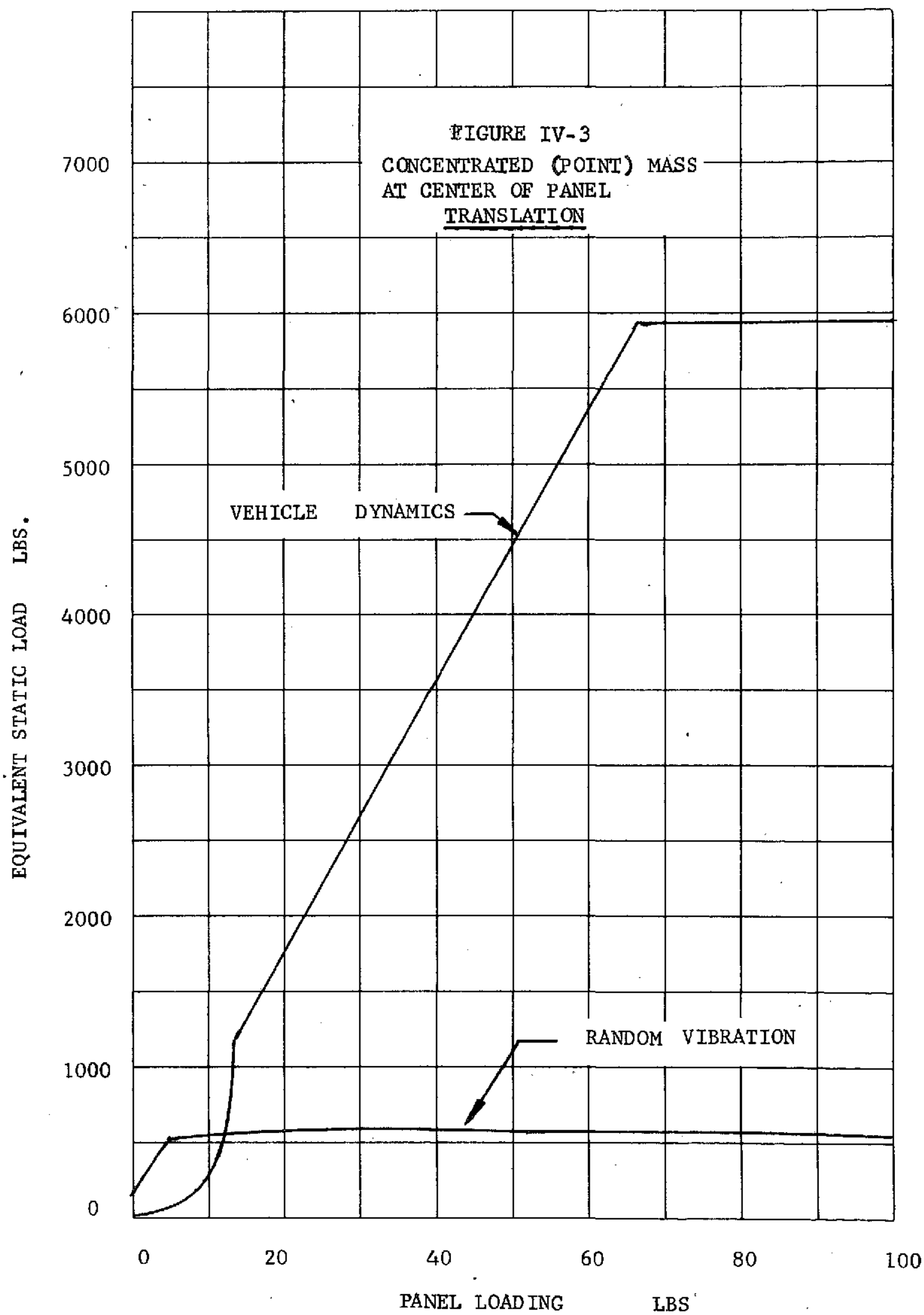


FIGURE IV-3
CONCENTRATED (POINT) MASS
AT CENTER OF PANEL
TRANSLATION
VEHICLE DYNAMICS
RANDOM VIBRATION
EQUIVALENT STATIC LOAD LBS.
PANEL LOADING LBS
0
1000
2000
3000
4000
5000
6000
7000
0
20
40
60
80
100

The equivalent static load was obtained by multiplying the package weight by the equivalent static load factor for each vibration case. Because simplified vibration mode shapes were assumed for this study, phasing between loads cannot be determined. Therefore, loading from each package is added to obtain total loading carried into the module support structure. It should be noted that vehicle dynamics excitation and the high level random vibration spectrum do not occur at the same time in flight; hence, loading from the two conditions should not be added.

3. Conclusions

The dynamics and loads study completed to date has established preliminary design load factors which can be used for initial design evaluation and sizing of the module structure. Even though past experience has shown that the results obtained by the methods used for this study provide adequate load factors for initial evaluation of structures, it should not be construed that the results accurately represent frequencies and dynamic loading of the module. The design procedure is actually iterative. As flight hardware is developed, a finite element mathematical model of the module should be developed. This can be used for more accurate loads calculations and also for predictions of environments to be experienced by equipment stowed in the module. Because of the high energy content of the random vibration spectrum as presently defined, fatigue analyses should be conducted; especially if the modules are to be reused for several flights.

B. STRESS ANALYSIS SUMMARY

The Universal Stowage Module structure was analysed using the dynamic loads described in section IVB, and the results of the stress analysis are shown in Table IV-4.

The beaded panel will support a 22.7 kiligram (50 pound) load in the worst case, and the maximum deflection would be 2.4 centimeters (0.951 inches) assuming a concentrated point load in translation. The limiting case is during vehicle dynamics. All loads up to and exceeding 36.3 kilograms (80 pounds) is acceptable in random vibration. In rotation, the panel is also limited at 22.6 kilograms (48 pounds) when considering a cubic shape approximately 38.1 centimeters (15 inches) on a side located in the center of the panel.

These are worst case conditions for the beaded panel. A concentrated load is impossible to duplicate, and if a cubic load of 416 kilograms per cubic meter (26 pounds per cubic feet) is assumed, there is no problem in translation. In rotation, a greater load capability could be realized if the load were either of a lower profile out from the panel, tied into another panel or divider, or placed off center on the panel. In any event, each panel will take 22.6 kilograms (48 pounds) up to a total module load of 36.3 kilograms (80 pounds). If the central divider is tied into a panel, the rigidity of that panel is increased considerably, thus increasing its load capability.

As shown in table IV-4 the remainder of the components and structure in the Universal Stowage Module will meet the design criteria of 36.3 kilograms (80 pounds).

TABLE IV-4 STRESS ANALYSIS SUMMARY

ITEM	LOAD, LBS	FACTOR OF SAFETY	LIMITING LOAD IN MODULE, LBS	REMARKS
Beaded Panel	4500	1.0	50	Concentrated Load (Per Panel) in Translation, Max Deflection at Center is 0.951 Inches.
	1700	1.0	48	Cantilevered Cubic Load (Per Panel) in Rotation, Deflection in One Half Mode is 0.238 Inches.
Front Flange	5444	1.03	80	
Front Lug Bolt	2948	1.80	80	3/8 Inch Diameter Launch Bolt
Rear Support Pin	2948	1.66	80	1/4 Inch Diameter Launch Pin
Central Divider	2872	1.04	80	80 Lbs Equally Distributed on Panel.
Calfax Receptacle	1400 Tensile 2500 Shear	1.89		
Drawer Guide	2872	2.35	80	
Module Door	2800	1.16	80	80 Lbs Bearing Against the Door
Door Latch	2800	3.60	80	
Door Hinge	2800	2.69	80	
Door Hinge Pin	1698	2.46	80	

APPENDIX A

DESIGN DRAWINGS

Martin Marietta Corporation Drawing Number	Title
849USM00000-009	Universal Stowage Module Assembly
-001	Front Flange
-002	Rear Flange
-003	Beaded Panel
-004	Door Housing
-019	Panel Assembly
-029	Door Assembly
849USM00001-009	Divider Assembly
849USM00002-009	Divider Rail Assembly
849USM00003-001	Drawer Divider Assembly
-002	Drawer Divider Partition
849USM00003-009	Drawer Assembly
-001	Drawer Guide